ECOLOGICAL INDICATORS

and

GUIDELINES for APPLICATION

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What is an Ecological Indicator?

INDICATOR

A sign or signal that relays a complex message in a simplified and useful manner

ECOLOGICAL INDICATOR

A measure, or a collection of measures, that describes the condition of an ecosystem or one of its critical components

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USAGE of ECOLOGICAL INDICATORS

PROBLEM FORMULATION

"What is the condition of our valued ecosystems?"

"Are conditions getting better or worse over time?"

"Which of our valued ecosystems is in the worst condition?"

"What stressors are associated with observed conditions?"

RISK MANAGEMENT

"Is our new policy resulting in the desired improvements?

Indicator Characteristics and Applications

TYPE:	• **Chemical, Biological, or Physical**
COMPLEXITY:	• **Measurement, Metric, or Index**
METHOD:	• **Field Measure, Remotely-Sensed, or Model Output**
DESIGN:	• **Intensive Site Study, Survey, or Inventory**
MEDIUM:	• **Aquatic, Terrestrial, or Multi-Media**
ASSESSMENT:	• **Status, Trend, Predictive, or Diagnostic**

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BIOLOGICAL INDICES

- **Fish**
- **Benthic Macroinvertebrates**
- **Periphyton**
- **Birds**
- **Amphibians**

Example Metrics

Family, Species Richness

Abundance

 # Sensitive spp.

% Tolerants

 # Trophic Strategies

% Carnivores

% Invertivores

% Omnivores

 # Reproductive Strategies

NOW DEVELOPING INTO BIOCRITERIA
FOR STATE WATER QUALITY MONITORING

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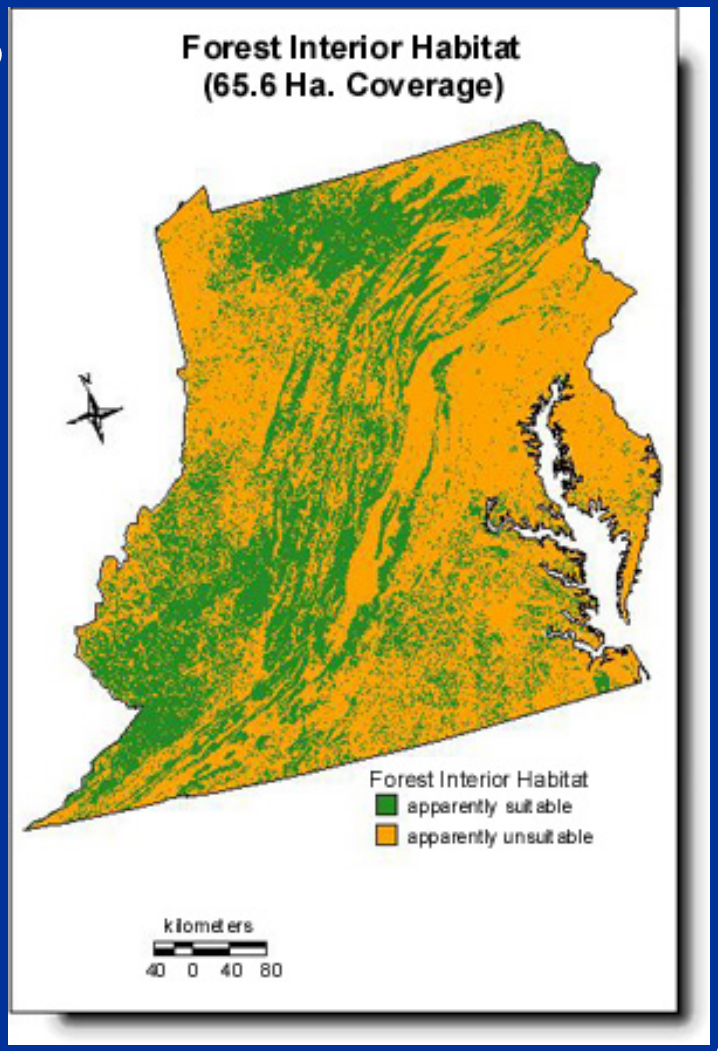
REMOTELY-SENSED INDICATORS

- Percent Land Cover
- Forest Fragmentation
- Percent Agriculture on Steep Slopes
- Density of Roads Crossing Streams
- Amount of Vegetated Riparian Zone
- Human Use Index



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INDICATORS UNDER DEVELOPMENT

- **Genetic Diversity**
- **Nutrient Cycling**
- **Coral Reef Indicators**
- **Submerged Aquatic Vegetation**
- **Watershed/Landscape Health**

"STAR" Grants Program
Office of Research & Development

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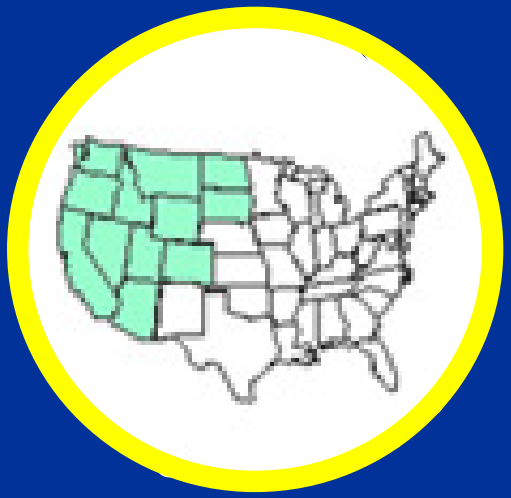
EMAP-West

- **EPA Regions 8, 9 & 10**
- **Stream, Estuarine, and Landscape Indicators**
- **Statistical Survey Design**
- **Intensive Augmentation Areas**
- **1999 – 2004**
- **Technology Transfer to States**



EPA Contacts:
Roger Blair (ORD, Corvallis, OR)
Janet Hashimoto (Region 9, San Francisco)

Evaluation Guidelines for Ecological Indicators

Objectives:

PRESENT A CONSISTENT SET OF ISSUES FOR CONSULTATION

- **During Indicator Development**
- **In Scientific Review**

ESTABLISH A STANDARD PROCESS FOR

- **ORD Indicator Researchers**
- **Partners Developing Indicators for ORD Monitoring Programs**
- **External Indicator Researchers working with ORD Funds**

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Derivation of Guidelines

- **INDICATOR DEVELOPMENT STRATEGY**
  (Environmental Monitoring & Assessment Program - EMAP)
- **PRESSURE-STATE-RESPONSE FRAMEWORK**
  (Organization for Economic Cooperation & Development)
- **GOVERNMENT PERFORMANCE & RESULTS ACT**
  (U.S. Government)

Compiled by the ORD Ecological Indicators Workgroup

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Document Format

CHAPTER ONE
Description of 15 Evaluation Guidelines

CHAPTERS TWO – FOUR
Illustration of the Guidelines
With Ecological Indicators under Development

- **Dissolved Oxygen Concentration**
- **Index of Benthic Condition**
- **Fish Community Index**

Four Recommended Phases of the Evaluation Process

1. **CONCEPTUAL RELEVANCE**
2. **FEASIBILITY OF IMPLEMENTATION**
3. **RESPONSE VARIABILITY**
4. **INTERPRETATION AND UTILITY**

Conceptual Relevance

Guideline 1:

RELEVANCE TO THE ASSESSMENT

Guideline 2:

RELEVANCE TO ECOLOGICAL FUNCTION

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1: Relevance to the Assessment

ASSESSMENT QUESTIONS

What is the Condition of Estuaries?

What Proportion of Estuarine Area has Degraded Ecological Condition?

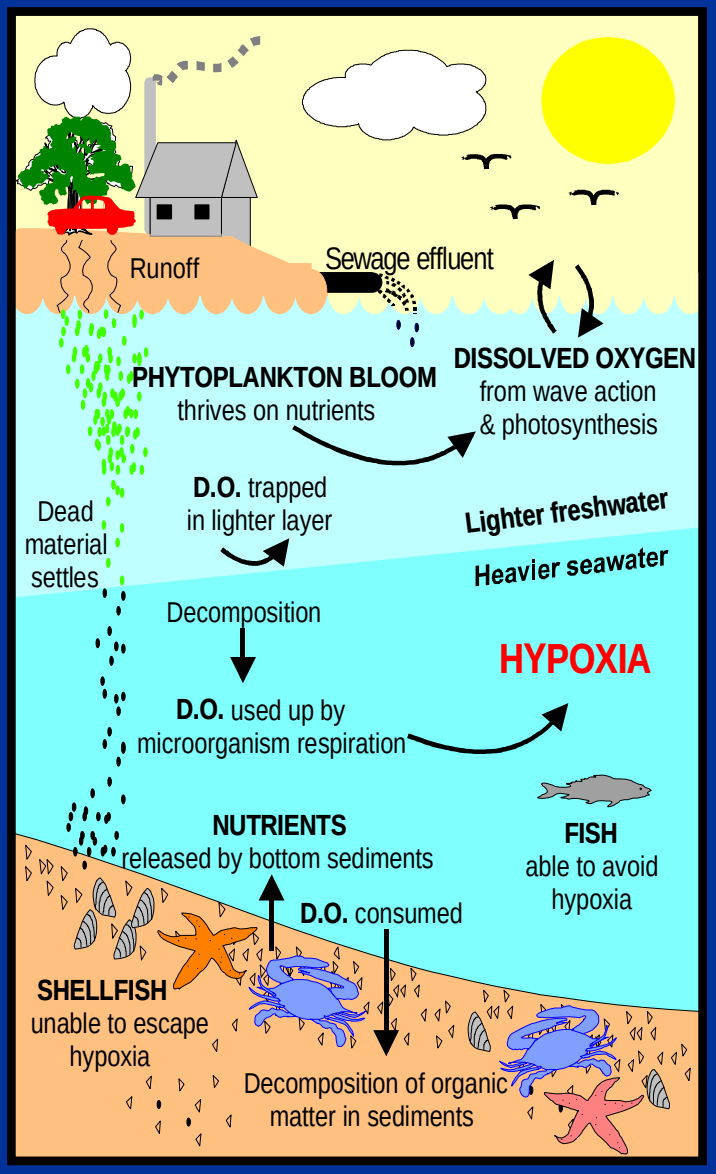
What Proportion of Estuarine Area has Degraded Benthic Communities?

INDICATOR

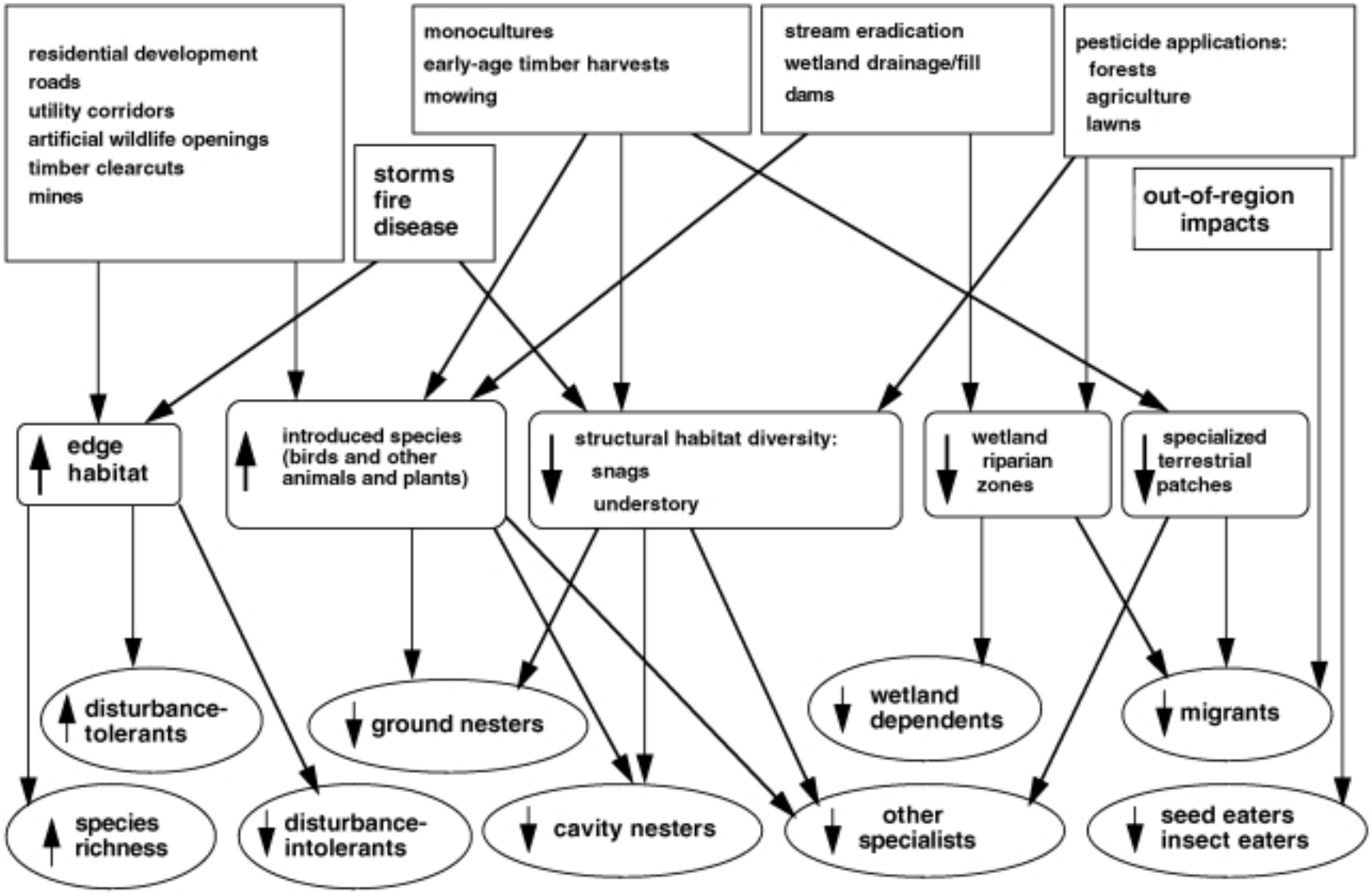
Index of Benthic Condition

2: Relevance to Ecological Function

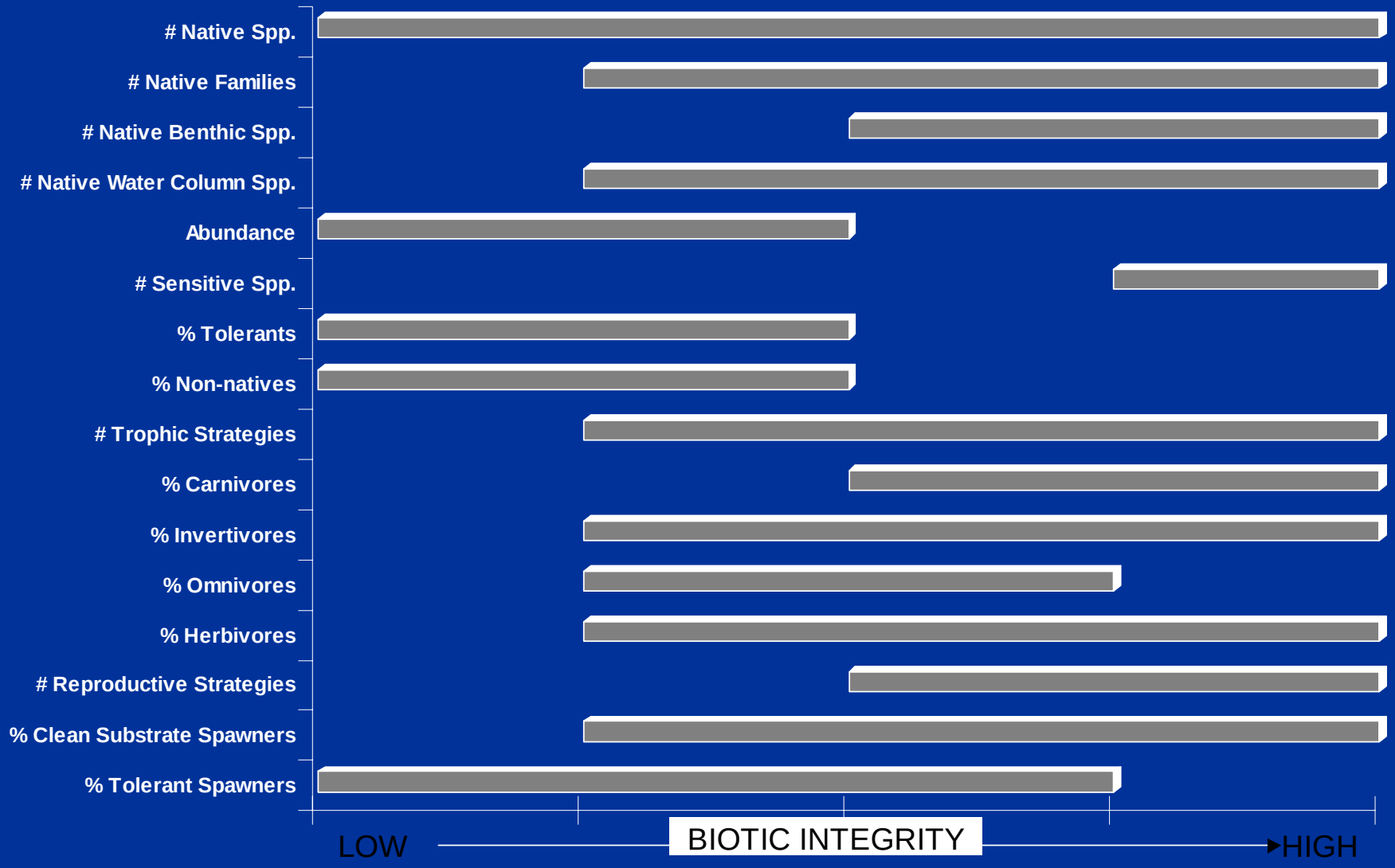
Dissolved Oxygen Concentration



Conceptual Model: Songbirds as Indicators of Ecological Integrity



Range of Metric Sensitivities - Fish Community Index



Feasibility of Implementation

Guideline 3: **DATA COLLECTION METHODS**

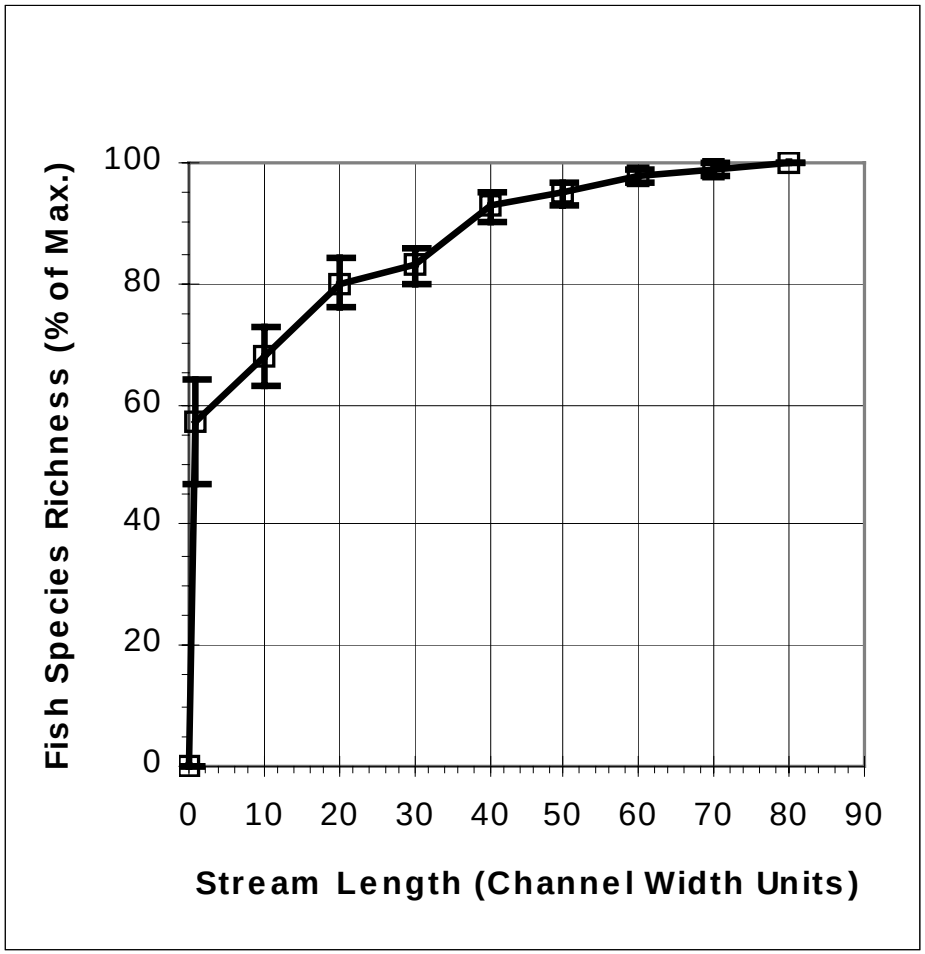
Guideline 4: **LOGISTICS**

Guideline 5: **INFORMATION MANAGEMENT**

Guideline 6: **QUALITY ASSURANCE**

Guideline 7: **MONETARY COSTS**

3: Methods - Fish Community Index



4: Logistics

ESTIMATE TYPE, TIME, AND EFFORT FOR:

- Site Access
- Field Crew
- Vehicles
- Travel
- Training
- Sampling Gear
- Data Transport
- Laboratory Facilities
- Laboratory Staff

5: Information Management

- **Time to Validate and Analyze Data**
- **Hardware and Software Requirements**
- **Critical Data Sets**
- **Metadata Requirements**
- **Data and Sample Archival**

6: Quality Assurance

Follow QA Procedures or Discard Data re:

- **SAMPLE COLLECTION**
- **SAMPLE PROCESSING**
- **SAMPLE STORAGE**

Perform QA Check for:

- **EXTRACTING ORGANISMS FROM MEDIUM**
- **COUNTING AND IDENTIFYING SPECIES**

Ex. For 10% of samples, calculate

$$\frac{\text{\# organisms originally sorted}}{\text{\# organisms originally sorted + additional \# found in re-sort}} \times 100$$

90-95% - Re-train technician **<90% - Re-sort batch**

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7: Monetary Costs

- Salary
- Lodging
- Travel
- Vehicles
- Sampling Equipment
- Laboratory Costs

Response Variability

Guideline 8: **ESTIMATION OF ERROR**

Guideline 9: **WITHIN-SEASON VARIABILITY**

Guideline 10: **ANNUAL VARIABILITY**

Guideline 11: **SPATIAL VARIABILITY**

Guideline 12: **DISCRIMINATORY ABILITY**

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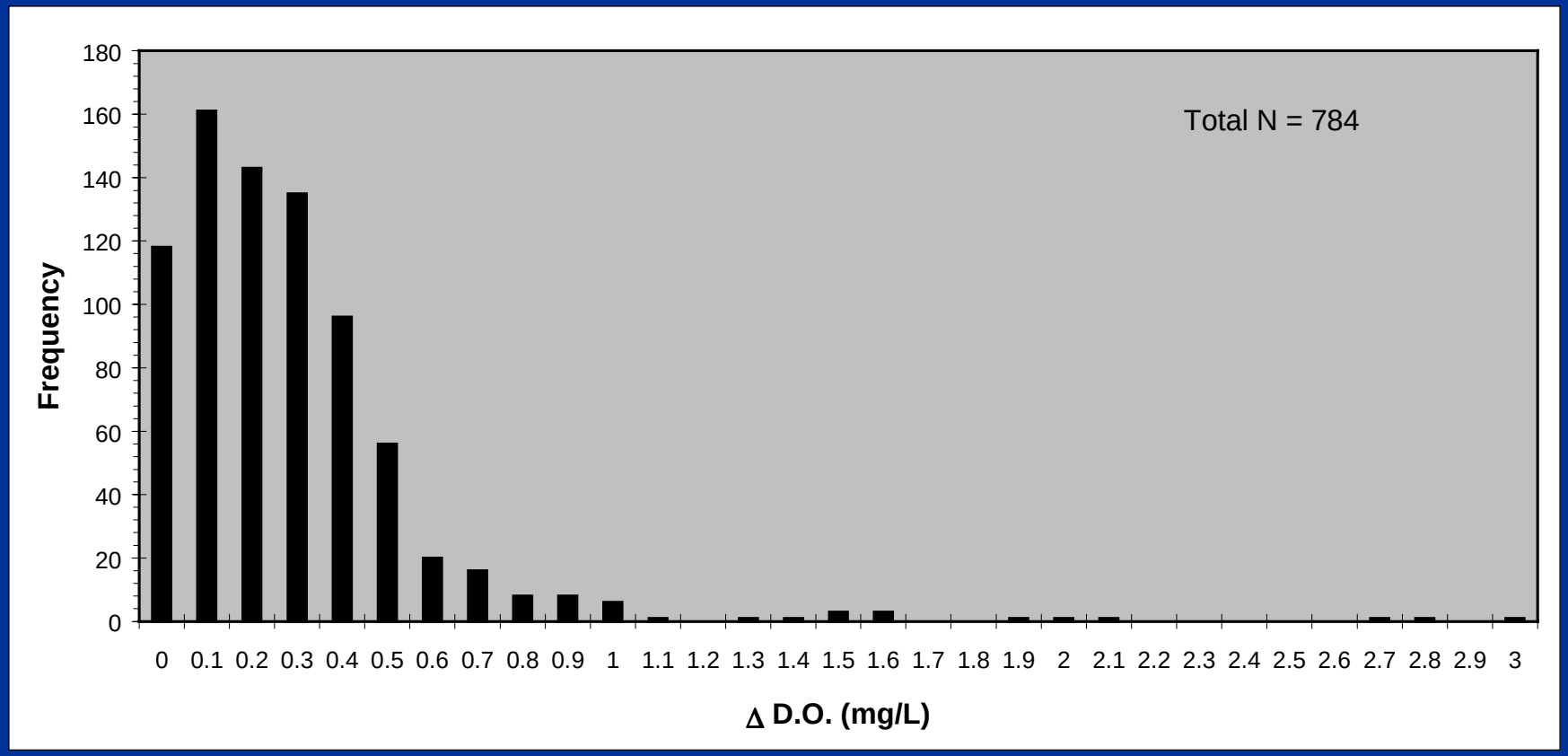
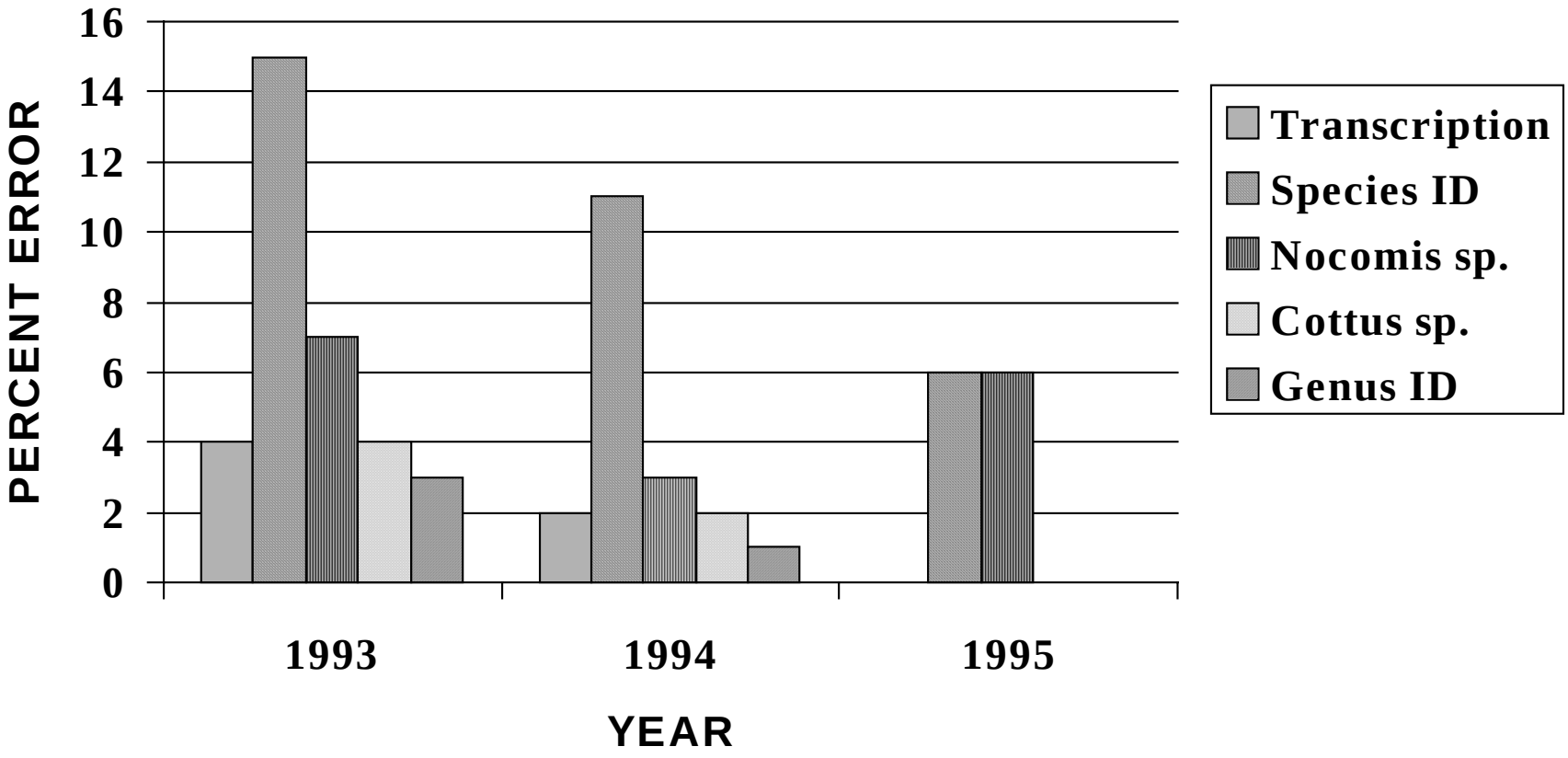
8: Estimation of Error
Dissolved Oxygen Concentration

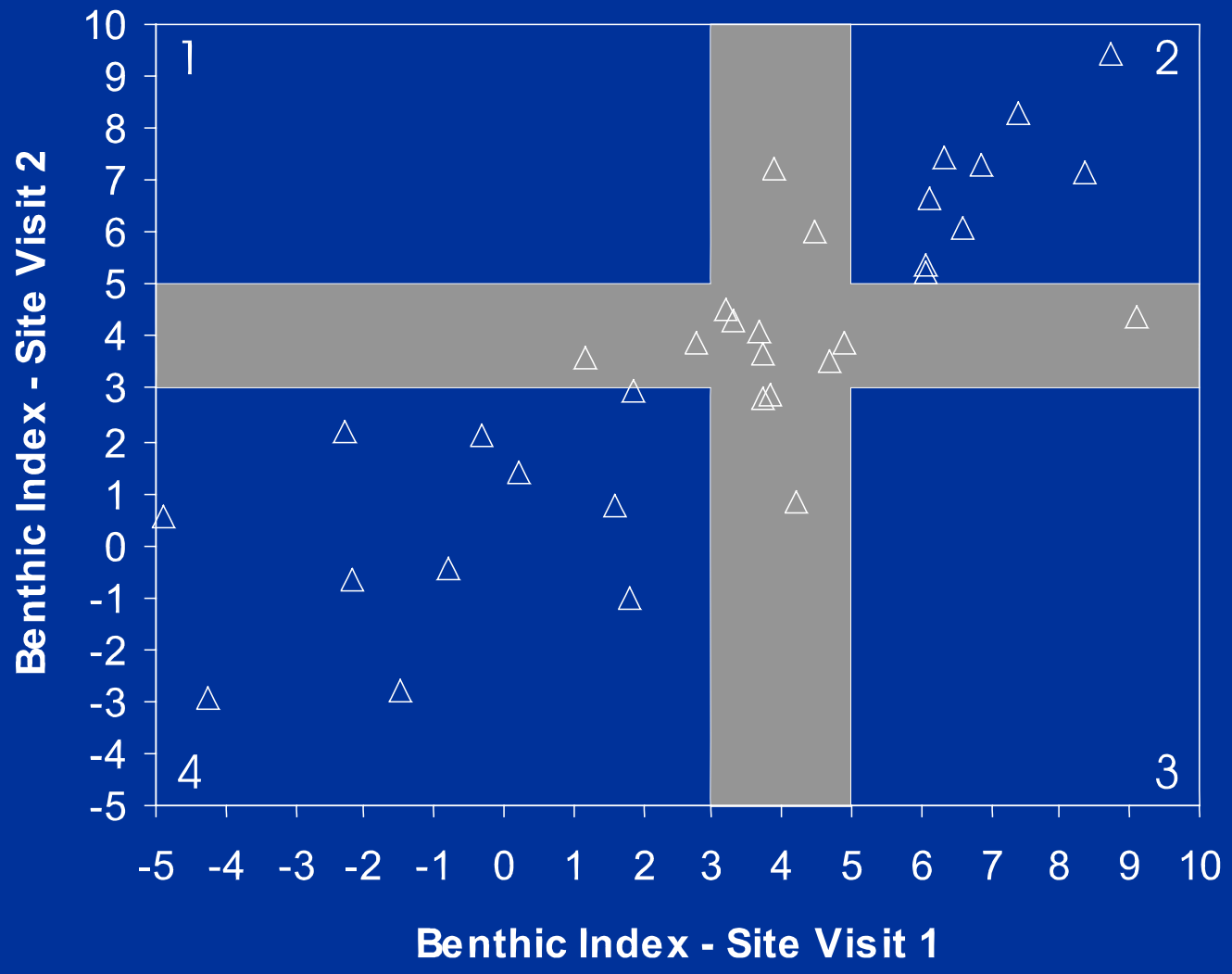


8: Estimation of Error

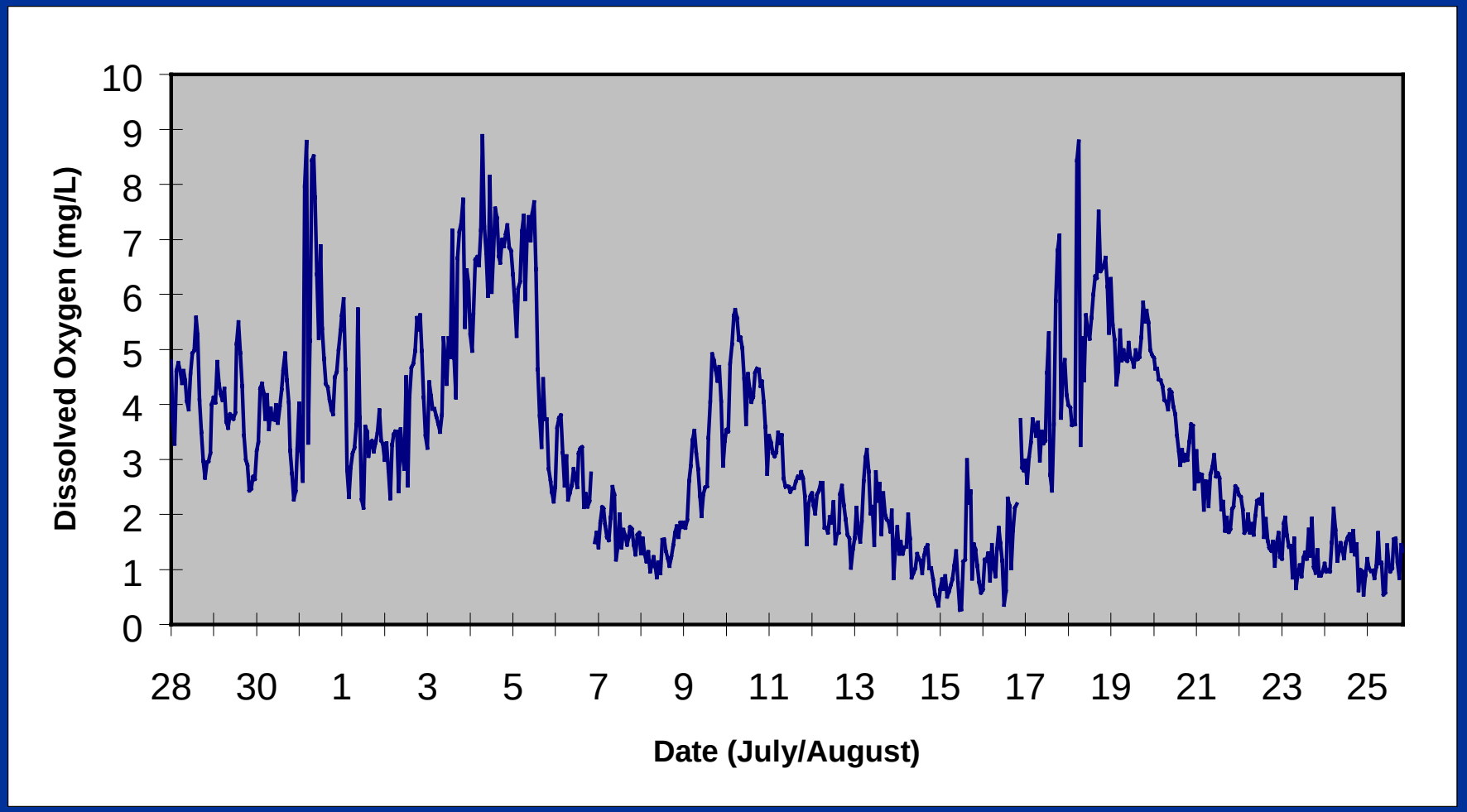
Fish Community Index



9: Within-Year Temporal Variability
Index of Benthic Condition

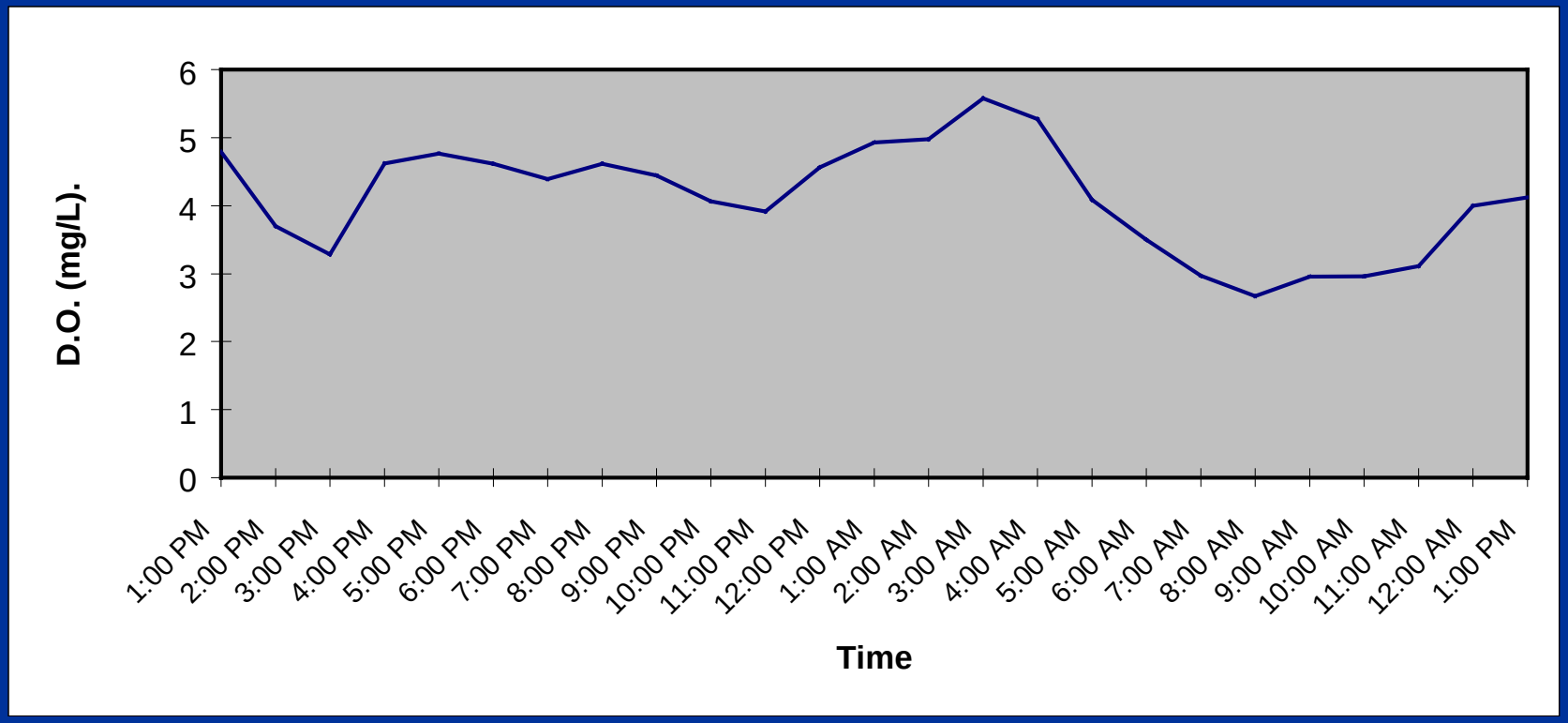


9: Within-Year Temporal Variability
Dissolved Oxygen Concentration

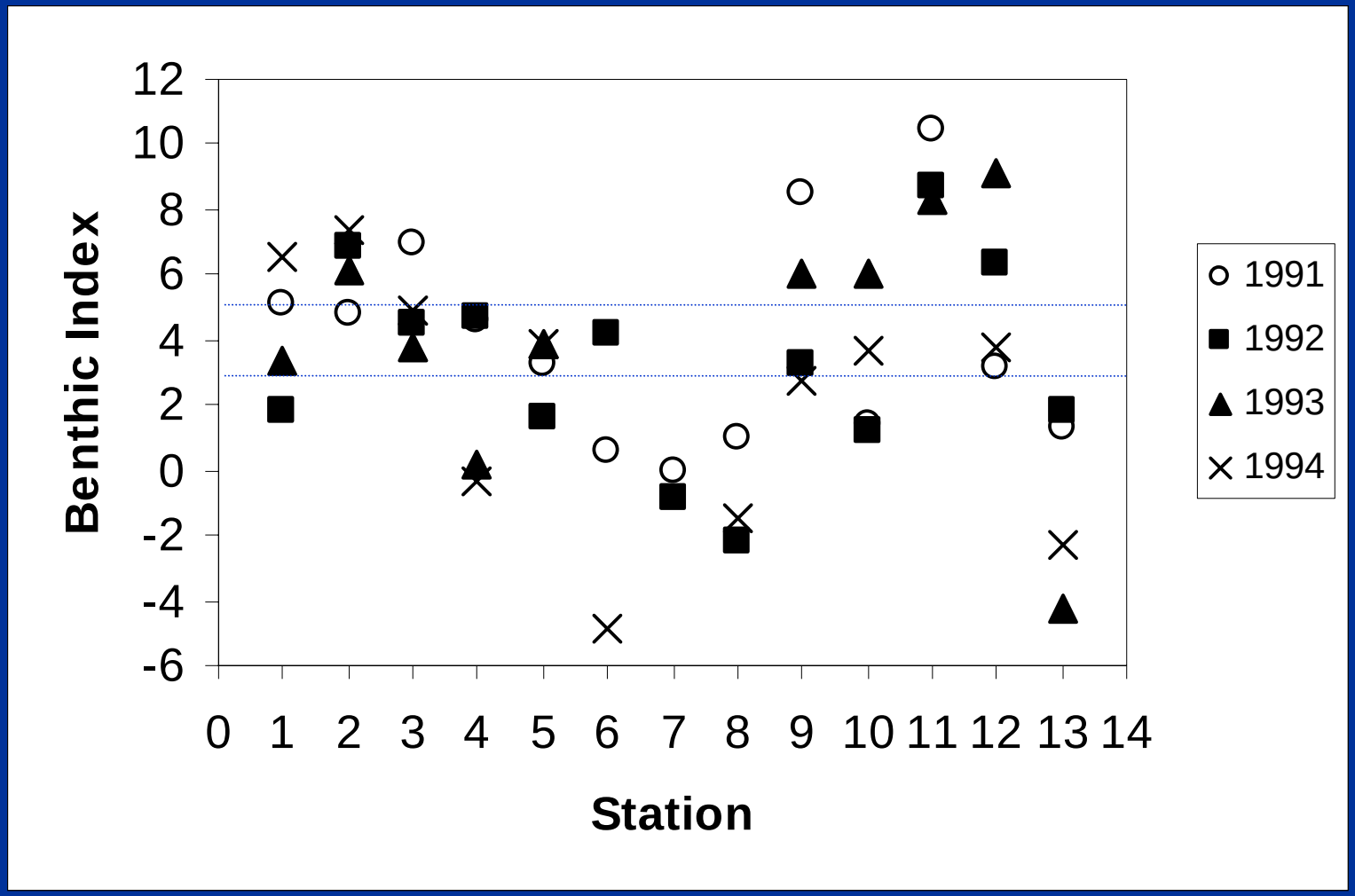


9: Within-Year Temporal Variability (Diurnal)

Dissolved Oxygen Concentration

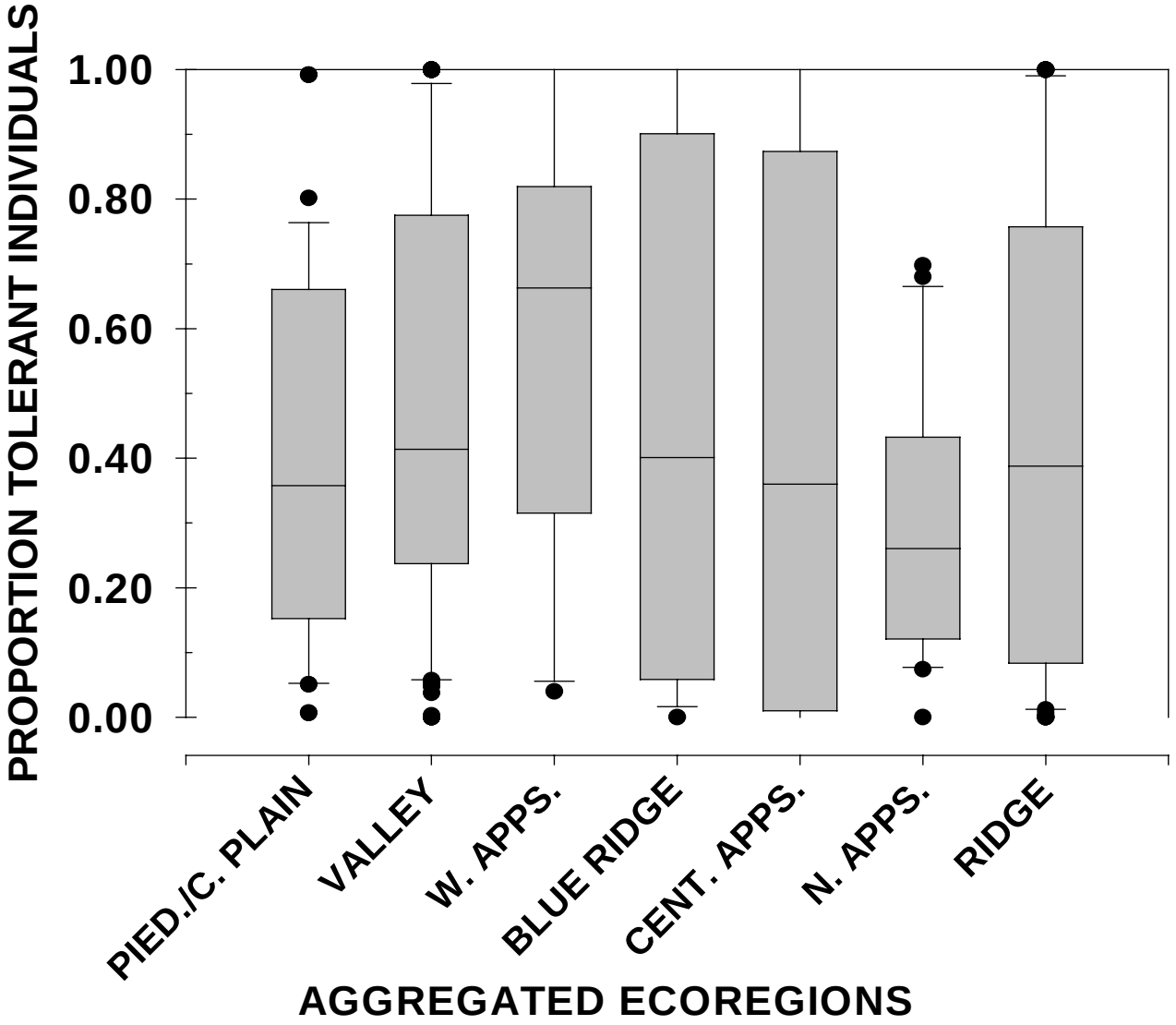


10: Across-Year Temporal Variability
Index of Benthic Condition

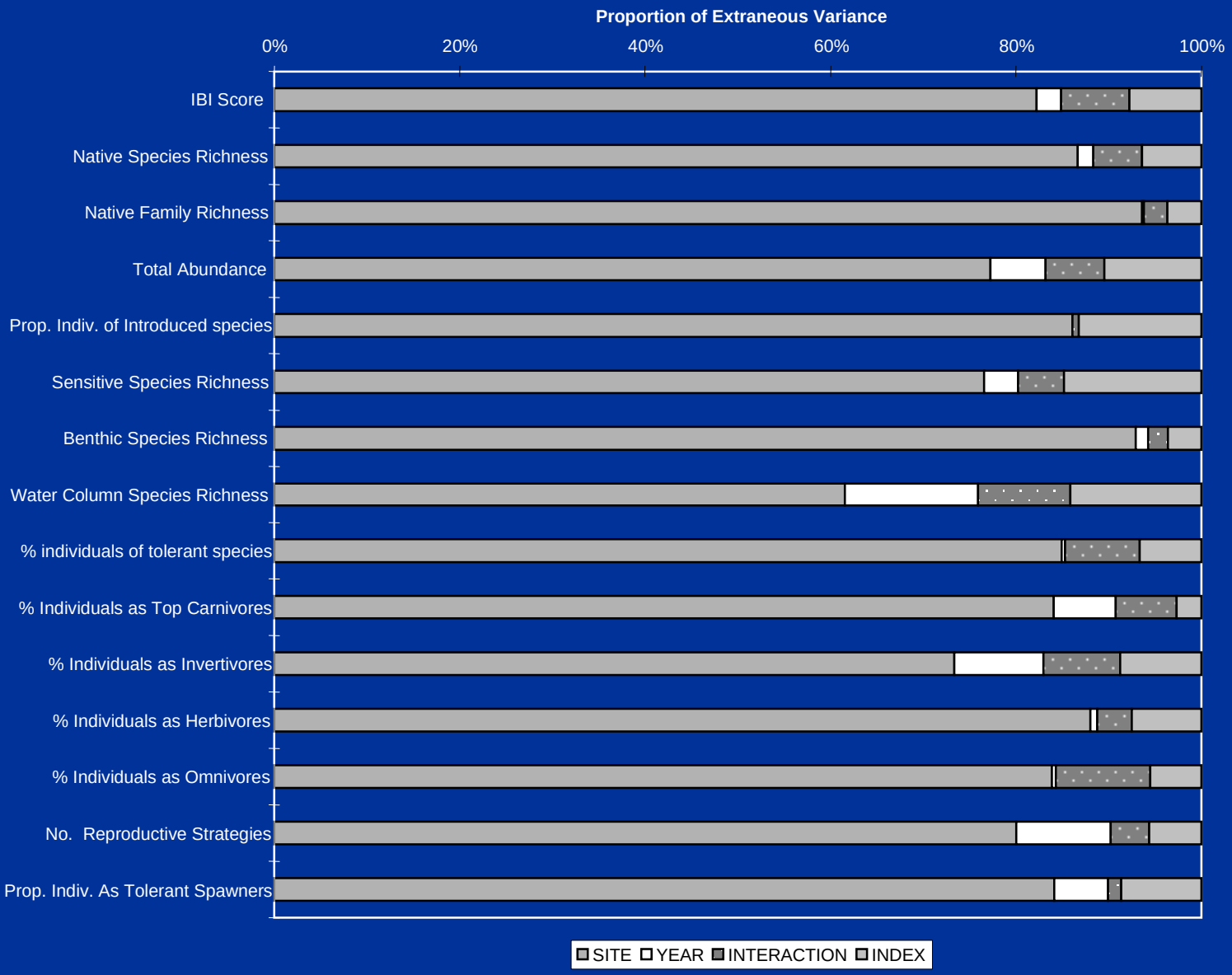


11: Spatial Variability

Fish Community Index



12: Discriminatory Ability - Fish Community Index



Interpretation and Utility

Guideline 13: DATA QUALITY OBJECTIVES

Guideline 14: ASSESSMENT THRESHOLDS

Guideline 15: LINKAGE TO MANAGEMENT ACTION

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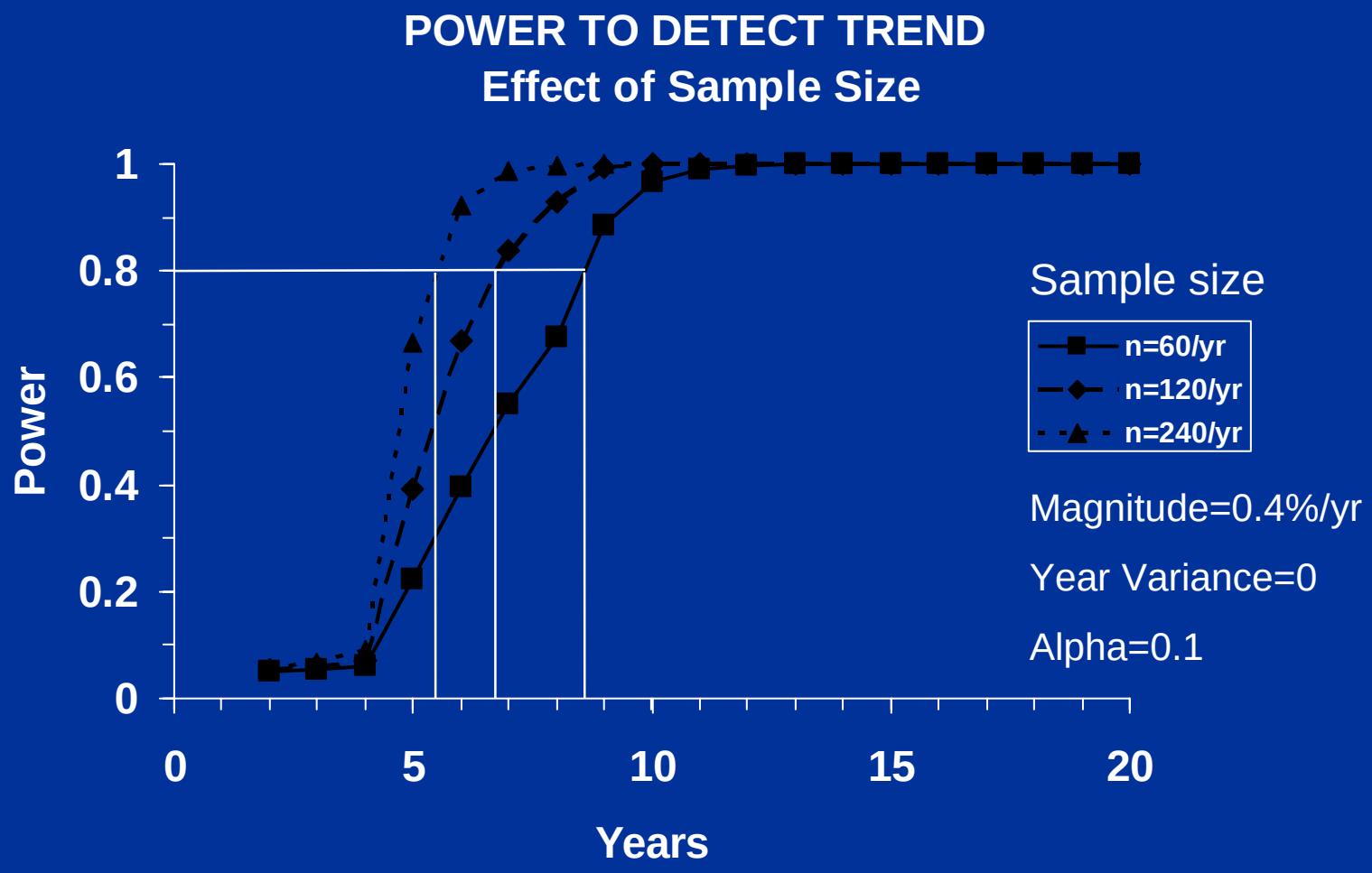
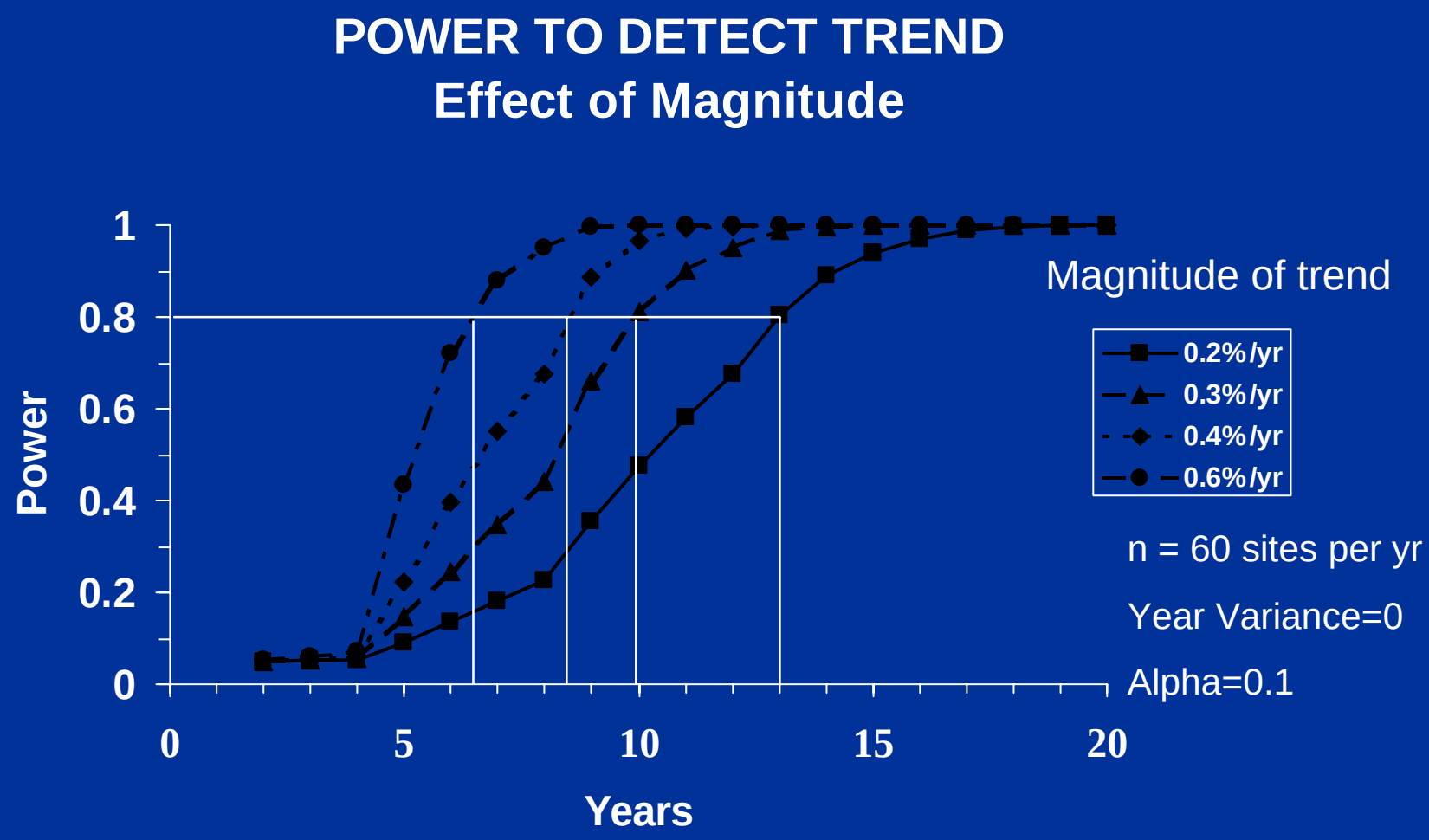
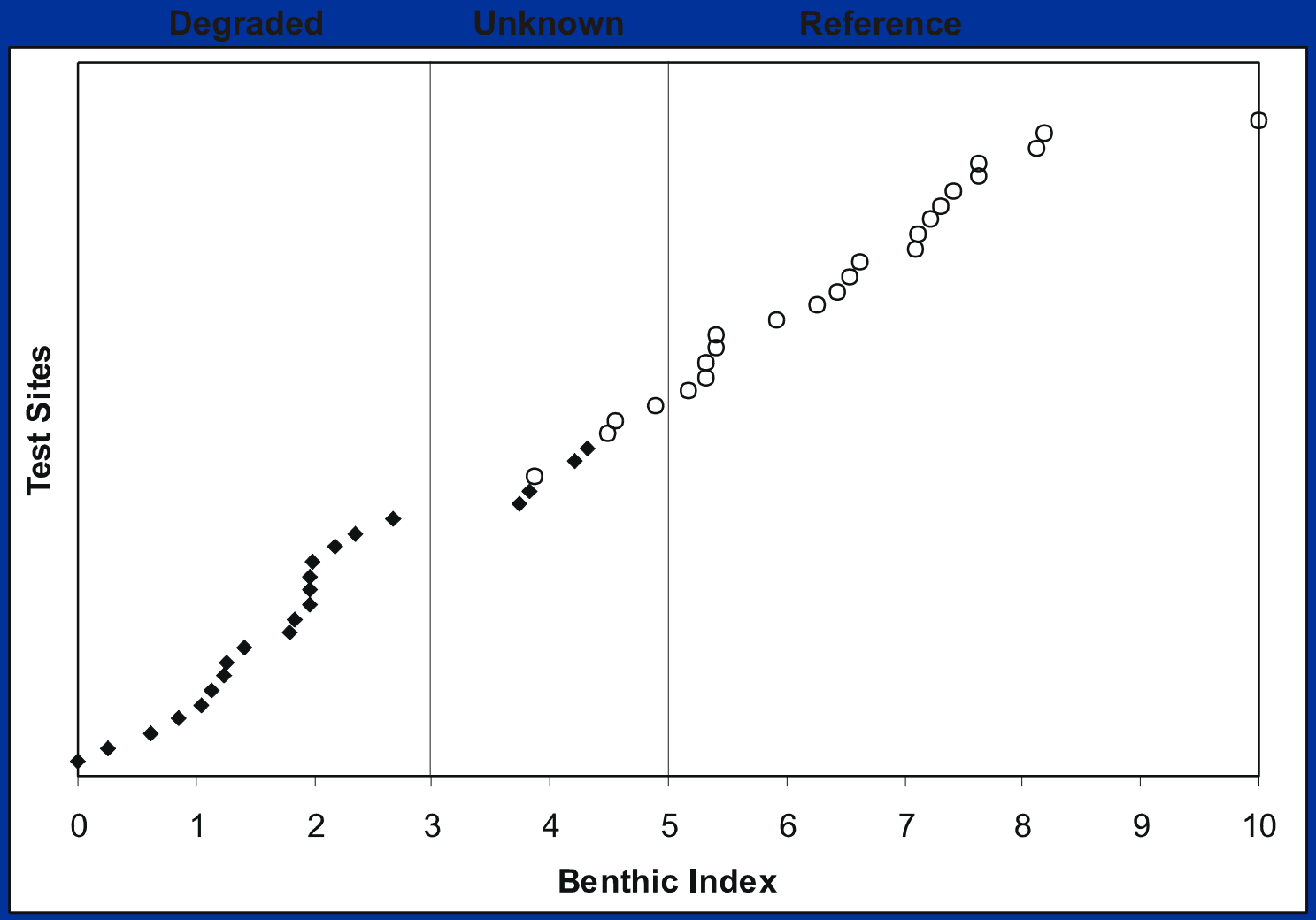
13: Data Quality Objectives
Fish Community Index



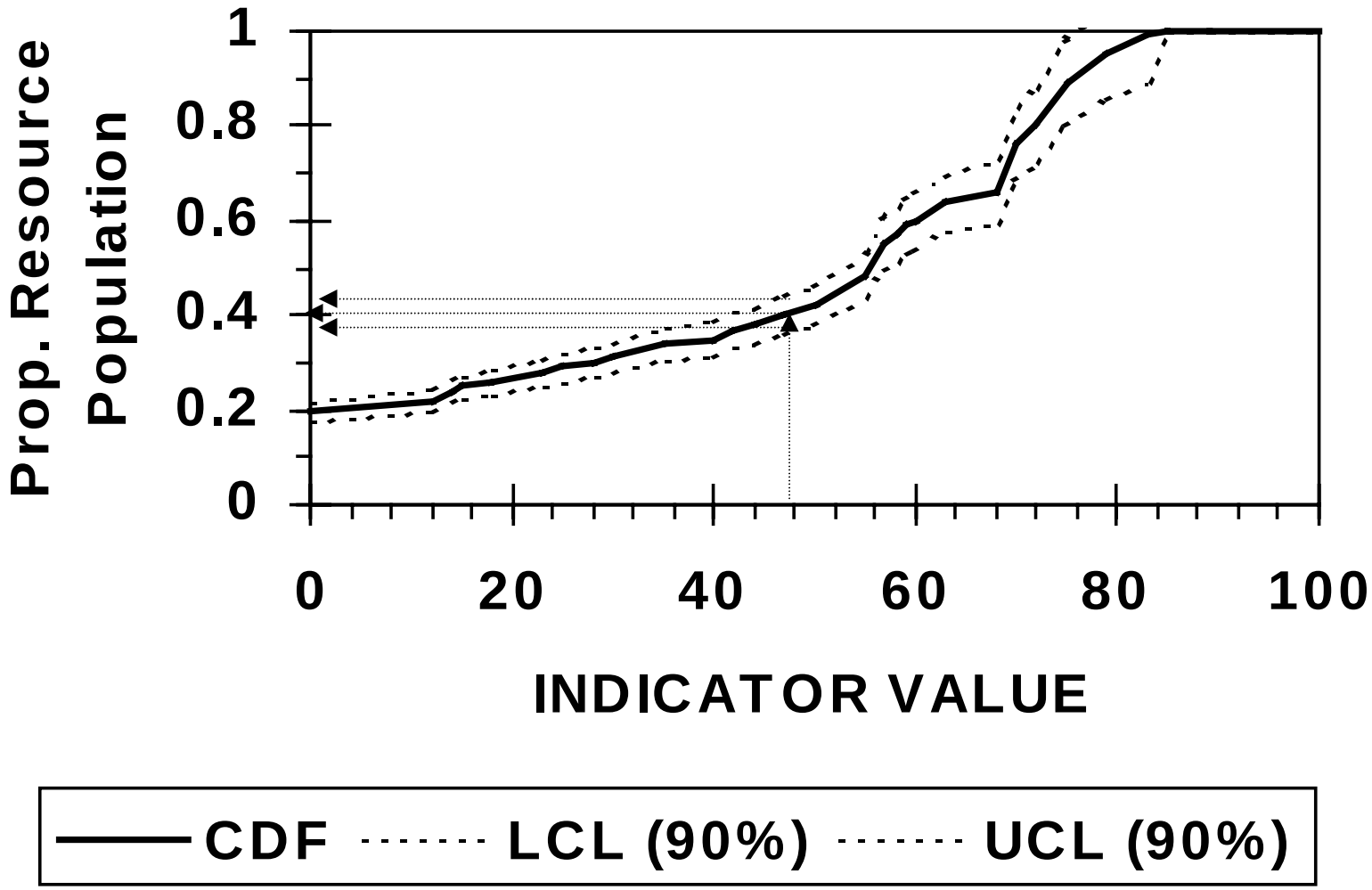
13: Data Quality Objectives
Fish Community Index



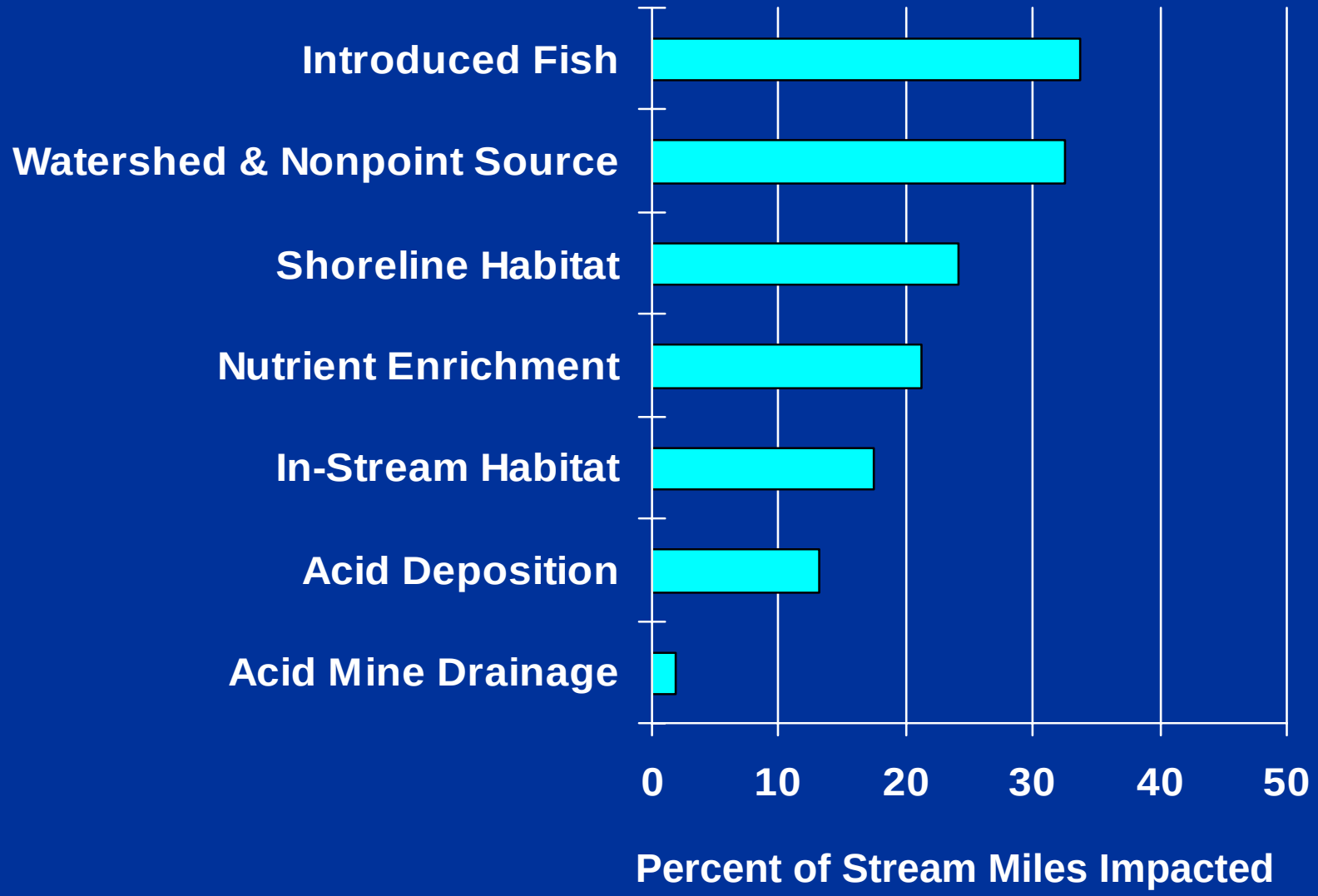
14: Assessment Thresholds
Index of Benthic Condition



15: Linkage to Management Action
Fish Community Index



Linkage to Management Action - Fish Community Index



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